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# Connecticut Agricultural Experiment Station

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## ECONOMY IN FEEDING THE FAMILY

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### III

## Food Oils and Fats

By E. M. BAILEY

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## Food Oils and Fats

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Chemically all fats resemble one another in that they are combinations of fatty acids with glycerin. Physically they differ in that some are liquid while others are solid. The term "fixed" or "fatty oil" is generally applied to those fats which, at the ordinary temperatures, remain in the liquid condition, but chemical industry has eliminated this natural distinction by the introduction of the "hydrogenating" or "hardening" process which converts liquid oils into the solid state.

As food stuffs fats belong to the same category as sugars, i. e., they are chiefly energy producers, in contrast with protein foods which are, in addition, tissue builders. When taken with other food in the diet, fats (and sugars) have the property of reducing the protein requirements of the body and this is what is meant by their so-called protein-sparing action. The calorific (energy-producing) value of fat is about 2.25 times as great as that of either protein or sugar, and it is practically the same regardless of the particular source of the fat or oil, or whether it be of animal or vegetable origin. By accurate measurement it has been found that one ounce of fat yields 264 calories to the body. On the basis of calorific values, substitutions among fatty foods in the diet may be made with considerable freedom, but personal tolerance, preference, or prejudice, will influence the choice in this as in other types of foods.

Although so nearly alike in energy-producing capacity, the fats show differences in other nutritional aspects. We refer especially to the growth-promoting properties possessed by some fats and lacking in others. It has been shown<sup>1</sup> that butter possesses this peculiar efficiency to a marked degree and that the efficiency resides in the butter fat itself. This shows us an additional and important reason for the effectiveness of milk as a food for children. Other fats show this property, among them beef fat, and, as

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<sup>1</sup> Osborne and Mendel Jour. Biol. Chem. 16. 423-37 1913; *ibid* 20, 379-90, 1915.

might be expected from their ingredients, the oleomargarines made of the so-called oleo-oil from beef fat. Lard and olive oil lack this peculiar property, as do those margarines also which are made from the commonly used vegetable fats and hydrogenated oils; as has been shown by Halliburton and Drummond.<sup>1</sup> The particular substances or properties responsible for this phenomenon are obscure, and as yet unidentified components of the fats. They have been detected in other types of food, and for lack of better definition have been called "vitamines" or "accessory diet factors."

Fatty foods not possessing the virtue just mentioned should not, however, be discriminated against on this account when used in the ordinary liberal diet, but it would appear to be inadvisable to eliminate butter entirely from the menu, particularly that of children.

We have referred already to the process of "hydrogenation," by which the physical and chemical characters of fats are modified, the conspicuous physical change being that liquid fats are hardened and converted into solids. The question of the wholesomeness and digestibility of fats so treated at once presented itself. The considerable amount of work which has been done on this subject has not resulted in anything to prejudice us against the use of products so treated. Upon this point Ellis<sup>2</sup> says: "It seems to be generally accepted by those who have investigated the matter, that the hydrogenated oils have as desirable a degree of digestibility as the oils from which they are derived." The debate as to their suitability for food has centered chiefly upon the presence of certain metals, more particularly nickel, which are used in the process of their manufacture. The amounts of nickel retained in the finished product, in the case of some hardened cottonseed oils, has been determined and quantities ranging from .020 to .075 milligrams per kilo (1,000 grams) found. The significance of such figures is better understood by comparing them with the quantities of nickel acquired by various foods prepared in nickel-lined cooking utensils which have been in common use for some years. Spinach contained from 25 to 27 milligrams per kilo; peas, 12 to 16; plums, 35; fruit cooked in 2% acetic acid (about one half the acid strength of ordinary vinegar), 65 to 67; cabbage, 83; sour-kraut, 127; potato, 80. No injurious effects have been attributed

<sup>1</sup> Jour. of Physiol., LI., p 250.

<sup>2</sup> Hydrogenation of Oils, Van Nostrand & Co., 1914, p. 144.



to the use of foods so prepared, yet it is seen that they contain amounts of nickel one thousand or more times greater than has been found in the hardened oils examined. However, it is perfectly obvious that this phase in the production of hydrogenated products should be carefully controlled.

The inspection of foodstuffs such as, of necessity, more and more engrosses the attention of this laboratory, involves tests for purity and tests to determine truthfulness of label or guaranty. When such inspections result in the detection of substances positively poisonous or deleterious to digestion and health, their value from the standpoint of public health is obvious to all. But instances of flagrant and vicious adulteration are largely passing out of the experience of the food control chemist of to-day, so that frequently the results of his labors lie within the realm of public health in its broader sense, which includes public economy. The substitution of one edible oil wholly or in part for another, and the sale of such substitute does not constitute a sin against the consumer's digestion, but it does defraud him of the difference in commercial values between the product he actually gets and that which he thinks he is buying. And now more than ever before he is anxious to protect himself in this direction. It is intended that our analyses should guide the consumer to intelligent purchasing; aid him to a better appreciation of comparative food values, and foster alertness to the deceptions of flashy labels and cunning advertising literature. Particularly at this time we desire to help him to co-operate in the program of economy that is being urged upon us.

These general considerations seem justified, in view of recent inquiries which have come to us on this subject. In addition we shall indicate briefly the source, preparation and composition of the principal fatty foods and summarize our accumulated experience with them. We shall include also some analyses not heretofore published, and some data, not our own, which may be of interest from a culinary standpoint.

Any classification of edible fats on the basis of their domestic uses will necessarily include the same fat in two or more classes, but for convenience we shall group them as follows: (1) Salad Oils. (2) Cooking fats and (3) Butter and its substitutes.

## SALAD OILS.

*Olive Oil.* The oil supplied by the fruit of the olive tree has been used as a food by man since the earliest times. Grown originally in oriental countries, its cultivation and use have extended through Mediterranean countries to South America, and it is now grown to a considerable extent in the United States, notably in California and Arizona.

About 50% of the fleshy part of the olive fruit is oil. The best grades of oil are prepared from fruit picked by hand just before maturity. These are crushed and the oil removed by gentle pressure, the first run being called "Virgin" oil or Sublime. This is generally characterized by a distinct greenish tinge of color due to the chlorophyll which is associated with the oil in the plant cells. Genuine oil may, however, lack this characteristic and may be pale or even deep yellow. Admixtures of peanut, sesame, poppy seed, corn and cottonseed oils with olive oil are much less common than formerly, although blending of inferior grades; i. e., oil obtained from repressings of the olive pulp, with higher grades is practiced to some extent in Europe.

*Cottonseed Oil.* A keen competitor of olive oil for table use is the refined oil of the cottonseed. Although produced in countries of Europe, Asia and South America, it is essentially an industry of the United States, where methods of refining lead those of other countries. The oil is unfit for use until it has been refined, which process includes deodorizing, decolorizing and "chilling," the latter step removing the high-melting fatty constituent (stearin), which would cause the oil to "cloud" in cold climates.

*Corn Oil.* In the process of making starch and glucose from maize or Indian corn the germ of the seed is removed. This germ contains about 15% of oil and yields the corn oil now appearing in our market. It is golden yellow in color and has a pleasant odor and taste.

A sample of corn oil examined in this laboratory<sup>1</sup> was found to be mixed with other oils, chiefly cottonseed oil. Thus early has this product been dignified and commercially flattered by adulteration.

*Peanut Oil.* Next in importance is peanut oil, of which there is an increasing production in the United States. Like cottonseed

<sup>1</sup> Connecticut Food & Drug Report, 1905, p. 121.

oil it must be refined before it is marketable as a food oil. The refined oil has a distinct nutty flavor which commends itself to some tastes.

*Other Oils.* Oils of the poppy-seed, rape, sesame and sunflower are not used alone to any extent in this country, but some of them may occur in admixture with the oils described above, either as adulterants or in legally marked compounds.

The commercial value of the oils described is in about the following order: olive, peanut, corn, cottonseed, the values of the others being intermediate between peanut and corn oils.<sup>1</sup>

#### SUMMARY OF THE RESULTS OF OUR INSPECTIONS OF THESE PRODUCTS.

Between 500 and 600 samples of olive oil have been examined in this laboratory since 1897, chiefly represented by six inspections. The percentage of total adulteration decreased from a maximum of 40% found in 1900, to 13.7% in 1909. It has been found that this product, put up in sealed containers, is freer from adulteration than that purchased in bulk from druggists, although the quality of druggists' goods has shown improvement. The general improvement is due in part to more truthful labeling practiced since 1905.

The following tabulation<sup>2</sup>, representing 448 samples, illustrates this point. No figures are given subsequent to 1909, because no representative number of samples has been examined in any one year.

TABLE I.—SUMMARY OF INSPECTIONS OF OLIVE OIL.

From Grocers	Year	Not found adulterated	Adulterated	Per cent. Adulterated
	1897	37	23	38.3
	1900	45	28	38.4
	1905	19	0	0.0
	1906	25	0	0.0
	1907	7	0	0.0
	1909	44	0	0.0
From Druggists	1897	13	5	27.8
	1900	17	13	43.3
	1905	21	9	30.0
	1906	55	11	16.7
	1907	65	11	14.5

<sup>1</sup> Leach, Food Inspection and Analysis, p. 516.

<sup>2</sup> Conn. Food & Drug Report, 1909-10, p. 214.

The adulterations found in these inspections were cottonseed, sesame and peanut oils. Such admixtures, as we have noted above, do not constitute a menace to health, and, if properly labelled, would not constitute an infringement of law.

Products sold under the name of "Salad Oil" our examinations have shown to consist wholly or in part of cottonseed oil. Such products are legally labelled; they do not purport to be any single oil and are sold under a distinctive name. Our experience has been, however, that they are often sold upon request for olive oil.

No oil other than olive should be sold as "sweet oil."<sup>1</sup>

### COOKING FATS.

The fats chiefly used by our grandmothers for culinary purposes were the rendered fats of hogs or beef, known respectively as lard or beef suet. To-day the housewife has a large array of shortening compounds at her disposal. These nearly always appear under trade names but may contain both the animal fats mentioned combined with a vegetable oil, such as cottonseed oil, or they may be entirely of vegetable origin. Other oils mentioned in the preceding section also occur in these compounds; any of them are adaptable to such use.

Our examination of some of the products in this group indicates their essential constituents to be as follows: Cotosuet<sup>2</sup>, cottonseed oil and beef fat; Cottolene<sup>3</sup>, cottonseed oil and beef fat; Korno<sup>4</sup>, corn oil, cottonseed oil and a harder fat like stearin; Waverly shortening<sup>5</sup>, beef stearin and cottonseed oil; Crisco, hardened vegetable oil, probably cottonseed; Vegetole, vegetable product containing cottonseed oil; Kuxit, vegetable product having the character of cocoanut fat; Wesson oil, cottonseed oil; Mazola, corn oil. A sample of Lard oil<sup>6</sup>, said to have been used for deep frying, was found to contain about half its weight of mineral oil. This mixture is unique for food purposes but common as a lubricant.

Recent analyses of some of these fats are given in Table II.

<sup>1</sup> U. S. Food Inspection Decision No. 139; Conn. Rules & Regulations No. 43.

<sup>2</sup> Connecticut Food Report 1896, p. 23.

<sup>3</sup> Connecticut Food Report 1896, p. 23, 1900, p. 145.

<sup>4</sup> Connecticut Food Report 1906, p. 122.

<sup>5</sup> Connecticut Food Report 1909, p. 278.

<sup>6</sup> Connecticut Food Report 1900, p. 148.



TABLE II—ANALYSES OF COOKING FATS.

No.	Brand.	Moisture.	Protein (N x 6.25)	Ash.	Fat.	Free fatty acids a; Oleic.	Refractometer reading at 40°C.	Reichert. Meissel No.	Halphen test.	Nitric Acid test.
		%	%	%	%	%				
8164	Wesson Oil	0.06	.....	.....	99.94	0.06	59.5	1.04	Red	Br. yellow
8165	Mazola....	0.00	.....	.....	100.00	0.17	62.5	0.86	Yellow	Red brown
8166	Vegetole...	0.02	0.38	0.02	99.58	0.15	59.5	0.45	Deep Red	Red brown
8167	Cottolene..	0.02	0.31	0.08	99.59	0.10	56.0	0.48	Deep Red	Red brown
8183	Crisco.....	0.20	0.19	0.05	99.56	0.18	54.7	0.50	Br. yellow	Br. yellow
8184	Kuxit. ....	0.31	0.13	0.03	99.53	0.15	37.0	5.03	Yellow	Yellow

The analyses show that the samples contain only traces of moisture and are practically all fat. The percentage of free fatty acid is very low. These are the substances prominently concerned in the changes which result in rancidity. A rancid fat or oil is one in which a part of the fat has been decomposed, by enzyme action it is believed, into free fatty acids and glycerine. The action of light and air upon these fatty acids produces the substances of disagreeable taste and odor associated with rancidity. An excess of free fatty acids does not necessarily indicate rancidity, but the conditions are favorable for rancidity to occur.

Edible fats and oils should be kept in securely closed containers protected from sunlight. Oils are more likely to become rancid than are solid fats. It is claimed as one of the advantages of hydrogenation that fats so treated remain wholesome for long periods.

Particular attention, with respect to the presence of animal fats, has been given to those products claiming to be of purely vegetable origin. In none of them have we found evidence of cholesterol, a characteristic constituent of animal fats. The following appear to be pure vegetable products, as claimed: Wesson oil; Mazola; Vegetole; Crisco; Kuxit.

There are few precise physical or chemical data by which to decide the desirability of one fat over another for culinary use. The housewife learns and decides by her experience which to use, judging by the results obtained. One thing she avoids, however, is the use of "smoky" fats for deep frying. The reason for this is that such a fat or oil "smokes" and gives off disagreeable vapors,

which will be absorbed by the food, before the desired cooking temperature is obtained. A desirable fat for deep frying, then, should have a sufficiently high burning point or smoke test. Blunt and Feeny<sup>1</sup> have determined this for a number of common cooking fats and their results are given here as of interest. The temperatures given indicate the degree of heat acquired by the fat or oil at the time it begins to give off visible fumes or vapors. The degrees have been converted to the ordinary Fahrenheit scale.

TABLE III.

Cottonseed oil (Wesson).....	451°
Snowdrift.....	450°
Crisco.....	448°
Leaf lard.....	430°
Butter fat.....	406°
Leaf lard heated 5 hrs.....	405°
Bulk lard.....	381°
Olive oil.....	347°
Peanut oil (1).....	323°
Peanut oil (2).....	300°
Cocoanut oil.....	277°

The recognized temperature for deep frying is 350°—400° F. It is apparent, then, that those fats decomposing below that temperature are not well suited to this particular purpose.

### BUTTER AND ITS SUBSTITUTES.

*Butter.* A typical butter contains about 15% of water and 85% of solids, of which 82.5% is milk fat and 2.5% other milk constituents and salt.

*Renovated Butter.* Renovated butter is made by melting genuine butter and separating the curd and water-soluble constituents of the original product. The fat so obtained is re churned with milk or cream, or both, and no other substances added except salt. Like butter, it must contain 82.5% of milk fat. The object of this treatment is to save butter which has become rancid or fallen off from prime quality.

*Oleomargarine* is a product which varies as to proportionality of ingredients and, to some extent, as to character of ingredients, but generally it consists of oleo oil, neutral lard, butter, milk, cream and salt. Vegetable oils, such as cottonseed oil, may be used in the mixture.

<sup>1</sup> Jour. of Home Economics, 7, p. 535, 1915.

Rigid rules are in force to govern the sale of both renovated butter and oleomargarine, in order to protect the butter industry. The controversy which has existed for many years concerning oleomargarine and butter is unfortunate, as each might well have its proper place in the trade. The tax placed upon oleomargarine has increased the price to the consumer for this perfectly wholesome and nutritious product.

*Nut Margarine.* There have quite recently appeared upon the market a number of brands of nut margarines. These products consist chiefly of cocoanut fat, with admixtures of cottonseed or other vegetable oils. The fats are churned with milk\* and salted, as in the preparation of butter. Color capsules accompany the package for the use of the consumer if he desires to color the product. It is not colored by the manufacturer as he is required to conform to regulations similar to those governing the sale of oleomargarine. The coloring we have found to be the vegetable color annatto, which is largely used for butter coloring.

Our analyses of some of these products are given in Table IV.

The analyses show some variation in water content but none contains excessive amount. All contain over 82.5% of fat. The ash varies considerably, due, in all cases, to the salt added. The free fatty acids are within normal limits for these products. Other tests must be interpreted with the knowledge that hydrogenation modifies them very materially. Nos. 8169 and 8170 are declared to contain 0.1% of benzoate of soda; they did not contain amounts in excess of this figure. No. 8168 made no statement as regards preservative; no preservative was found.

The diagnosis of mixtures of this kind is more difficult for the reason that hydrogenation changes the chemical as well as the physical properties of fats, so that their response to the usual tests is either modified or destroyed.

As we have stated elsewhere in this paper, nut margarines are supposedly composed of vegetable fats only, while in oleomargarine animal fats are used, with or without fats of vegetable origin. As in the case of cooking fats, we have looked particularly for evi-

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\* The flavor of butter is due to the action of lactic acid-forming bacteria in the milk from which it is churned. Nut margarine fats are ripened with milk to which a culture of such bacteria has been added to impart the flavor of butter. [Pickard. The Am. Food Jour., Jan. 1918.]

TABLE IV—ANALYSES OF BUTTER SUBSTITUTES.

Number	Brand	Moisture.	Protein (N x 6.25.)	Ash.	Fat.	Free fatty acids as Oleic.	Refractometer reading at 40° C.	Reichert- Meissel No.	Halphen test.	Nitric Acid test.
		%	%	%	%	%				
8168	<i>Nut Margarine.</i> A 1 Brand, Downey Farrell Co., Chicago...	10.84	1.25	4.51	83.40	0.45	40.0	7.00	Deep pink	Brown
8169	Cocoanut Brand, Nucoa Butter Co., Soho Park, N. J.	6.53	0.69	1.58	91.20	0.39	37.2	7.50	Yellow	Brown
8170	Providence Churn- ing Co., Prov., R. I.	11.28	0.75	1.14	86.83	0.47	39.0	6.15	Yellow	Yellow
8171	<i>Oleomargarine</i> Lily, Swift & Co..	1.67	0.56	0.41	97.36	0.74	52.0	1.50	Deep red	Red brown
8172	Premium, Swift & Co. ....	2.54	0.63	0.60	96.23	0.63	49.2	0.99	Red	Red brown
8173	Gilt Edge, John F. Jelke Co.	8.52	1.25	1.62	88.61	0.74	49.2	....	Pink	Red brown
9994	Good Luck, John F. Jelke Co.	9.20	1.00	3.08	86.72	0.50	49.3	....	Red	Red brown
8175	Silver Churn, Armour. ....	4.90	0.56	1.44	93.10	0.80	51.0	1.30	Deep red	Red brown

dence of animal fats in the nut margarines but with negative results. There is nothing shown by our analyses inconsistent with the claim that they are vegetable products. They are very palatable preparations and may well be substituted for a part of the family butter supply, thereby conserving animal fats.

#### MILK-BUTTER MIXTURE.

The present is a fruitful time for invention and device designed to appeal to public economy. Such a device is one advertised of late, for which it is claimed that two pounds of butter or table butter can be made from one pound of butter and one pint of milk. While the fine distinction is made that you start with butter and milk and produce "table" butter, no distinction is made between the commercial values of the two substances. Both the expressed and implied thought is that from one pound of butter at (say) 55 cents per pound and one pint (pound) of milk at 7 cents per pint, two pounds of butter or "table" butter are produced, valued at \$1.10.



The true story of this economic idea may be simply told by the following table:

Substance.	Composition.	Food Value Calories.	Commercial Value.
1 lb. Butter	85 parts solids, 15 parts water, 82.5 parts fat.	3478	\$0.55
1 lb. Milk <sup>1</sup>	12 parts solids, 88 parts water, 4.0 parts fat.	305 <sup>2</sup>	0.07
2 lbs. Milk-Butter mixture	97 parts solids, 103 parts water, 86.5 parts fat.	3783	1.10
or per lb. mixture	48.5 parts solids, 51.5 parts wa- ter, 43.3 parts fat.	1892	0.55

<sup>1</sup> One pint of milk may be called one pound.

<sup>2</sup> Basis of 4.5% sugar and 2.8% protein.

Whatever the finished product is called, it is watered butter, as a comparison of the composition and food value of the finished product with the original shows. As to the commercial value of the product, if it is worth the combined value of the ingredients, 62 cents, then the cost to the consumer per 100 calories is practically the same as in the original butter, 1.6 cents; if it is worth \$1.10, then the consumer pays nearly twice as much; viz., 2.9 cents per 100 calories. The two pounds of mixture will "go as far" as two pounds of butter in the same sense that a pint of milk diluted with a pint of water will go as far as a quart of milk. The same economy will be effected by drinking the pint of milk and serving half portions of butter. This device may be looked upon as an ingenious method for serving half portions.











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